SURFACE PRODUCTION TOOL

Valve:

A valve is a device used to regulate, direct, or stop the flow of a fluid through a pipe, tube, or other passageway. Pipeline valves are pressure-containing devices designed to control, isolate, direct, or regulate fluid flow within oil and gas transportation systems while maintaining system integrity under specified pressure and temperature conditions.

Common Examples:

- The tap (faucet) on a sink is a valve.
- The valve on a bicycle tire controls air flow.
- Heart valves in the human body control blood flow.

Functions of a Valve:

- **Flow Isolation** – Shuts off flow during maintenance or emergencies.
- **Flow Regulation** – Controls the flow rate of oil or gas.
- **Pressure Control** – Maintains desired operating pressure.
- **Backflow Prevention** – Prevents reverse flow that could damage equipment.
- **Emergency Shutdown (ESD)** – Rapidly isolates sections of a pipeline during accidents or leaks.

Types of Valves:

1. **Gate Valve:**
    - It is most common type of valve
    - It is fully open or fully closed
    - Minor pressure loss when fully open
    - When the handwheel or actuator is turned, the gate moves **upward** to open the valve
    - When the gate moves **downward**, it blocks the flow path and stops fluid flow completely.

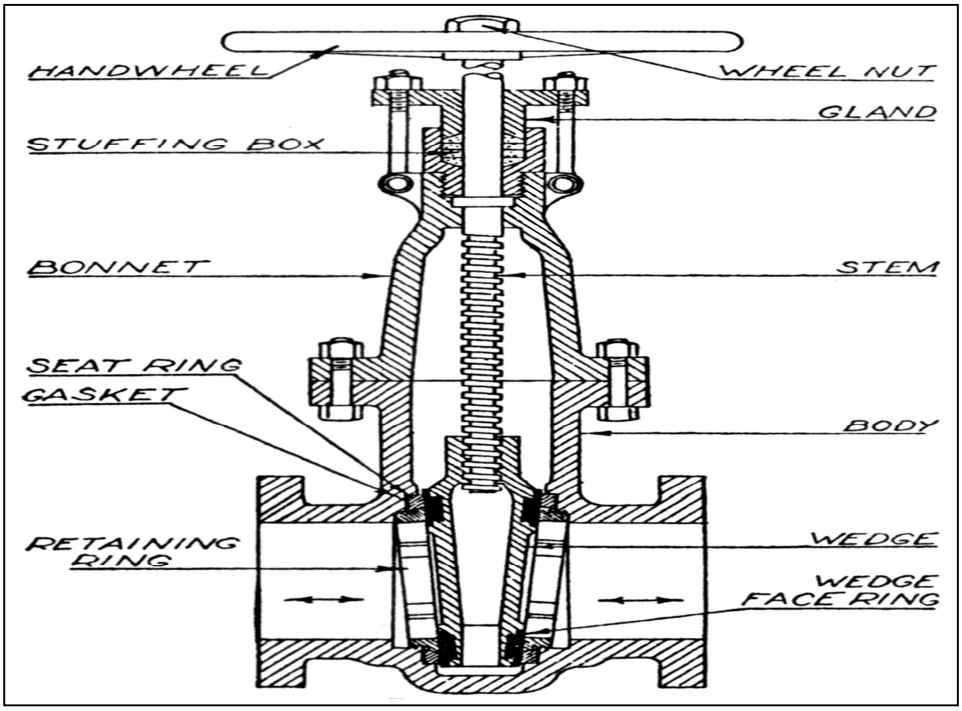

Figure: Gate Valve

Types of Gate Valves

- Rising Stem Gate Valve – Stem moves up and down visibly during operation.
- Non-Rising Stem Gate Valve – Stem remains stationary externally.
- Solid Wedge Gate Valve
- Flexible Wedge Gate Valve
- Split Wedge Gate Valve
- Knife Gate Valve – Mainly for slurry and viscous fluids.

2. Ball Valve:

A ball valve is a rotary motion valve in which a hollow, perforated ball rotates 90° to open, close, or regulate fluid flow.

- Suitable for high-pressure and high-temperature applications.
- Low pressure drop due to full-bore design.
- Ball valves are preferred for **pipeline isolation and emergency shut-off** because they provide rapid operation and tight sealing.

Types of Ball Valves

- Floating Ball Valve – Ball is supported by valve seats.
- Trunnion-Mounted Ball Valve – Ball is supported by trunnions; used for large-diameter, high-pressure pipelines.
- Full-Port Ball Valve – Bore diameter equals pipe diameter, minimizing pressure loss.
- Reduced-Port Ball Valve – Bore is smaller than pipe diameter.
- V-Port Ball Valve – Designed for flow control and throttling.

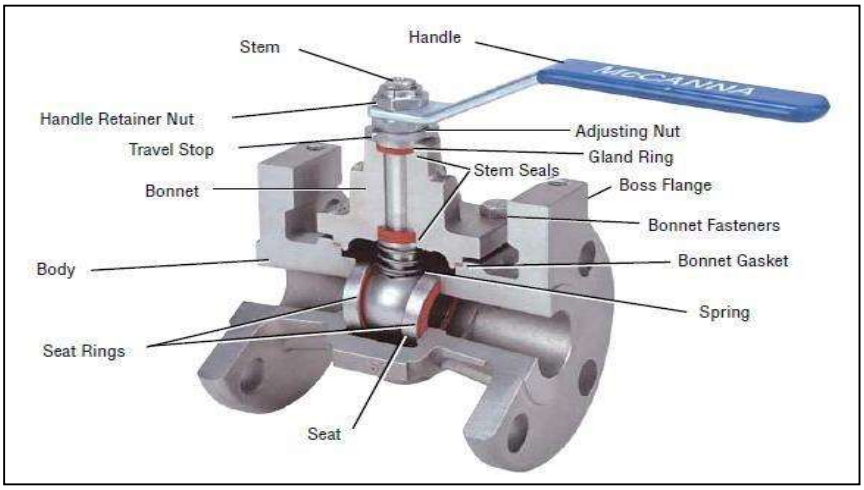

Figure: Ball Valve

3. Butterfly Valve:

A butterfly valve is a valve in which a disc rotates through 90° about its axis to start, stop, or regulate the flow of fluid. Butterfly valves are commonly used in **large-diameter, low-to-medium pressure pipelines** where compact size, low weight, and rapid operation are important. Triple-offset butterfly valves are often selected for critical oil and gas applications because they provide improved sealing performance and reliability.

- **Open:** Disc rotates parallel to the flow direction, allowing fluid to pass.
- **Closed:** Disc rotates perpendicular to the flow, blocking the passage.
- Lightweight, compact & Quick operation.
- Requires less space than gate valves.

Types of Butterfly Valves

- Concentric Butterfly Valve
- Double Offset Butterfly Valve
- Triple Offset Butterfly Valve (widely used in oil & gas for high-pressure and high-temperature service)

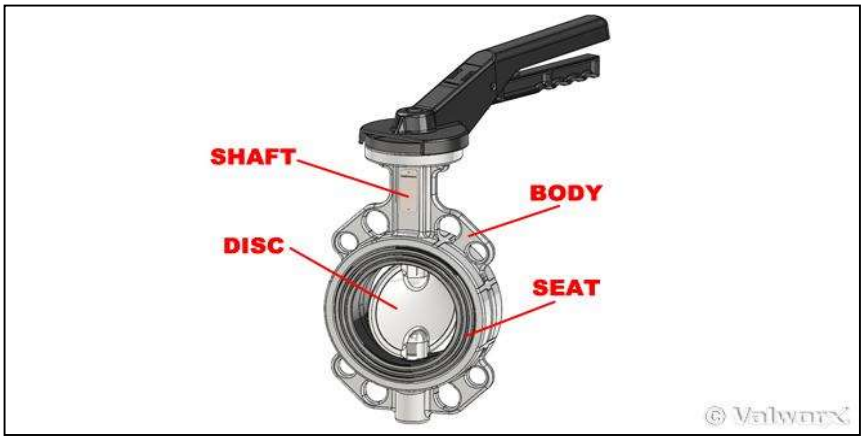

Figure: Butterfly Valve

4. Check Valve (Non-Return Valve / NRV):

A check valve is a self-acting valve that opens with forward flow and closes automatically when flow reverses, preventing backflow. Check valves are installed downstream of pumps and compressors to prevent reverse flow that could damage equipment or disrupt operations. They are essential safety devices in oil and gas transportation systems, ensuring fluid moves only in the intended direction and protecting pipeline integrity.

- When fluid flows in the correct direction, the pressure pushes the disc away from the seat, opening the valve.
- If the flow reverses, the disc automatically returns to the seat due to gravity, spring force, or reverse pressure, preventing backflow.

Types of Check Valves

- Swing Check Valve – Uses a hinged disc that swings open and closed.
- Lift Check Valve – Disc moves vertically.
- Ball Check Valve – Uses a ball to block reverse flow.
- Dual-Plate Check Valve – Two spring-loaded plates; compact design.
- Spring-Loaded Check Valve – Fast closing and reduced water hammer.

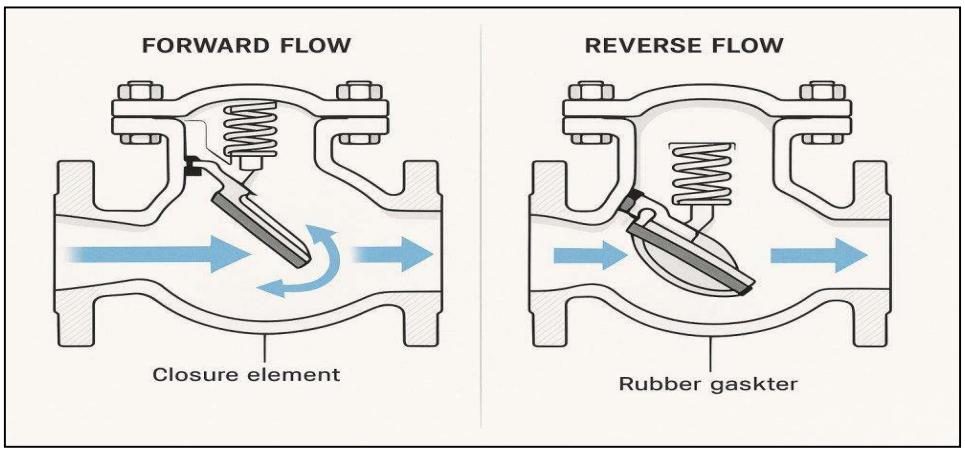

Figure: Check Valve

5. Globe Valve:

A globe valve is a valve in which a disc moves perpendicular to the seat to regulate, start, stop, or throttle fluid flow. Unlike gate and ball valves, which are mainly used for isolation, globe valves are preferred when **accurate flow regulation** is required. They are commonly installed in process plants, refineries, and production facilities where operators need to control flow rate, pressure, or fluid distribution.

- Turning the handwheel moves the stem and disc up or down.
- **Disc raised:** Flow passage opens.
- **Disc lowered:** Flow is restricted or completely stopped.
- The valve can be partially opened to precisely control flow rate.

Types of Globe Valves

- Z-Type Globe Valve (most common)
- Y-Type Globe Valve
- Angle Globe Valve

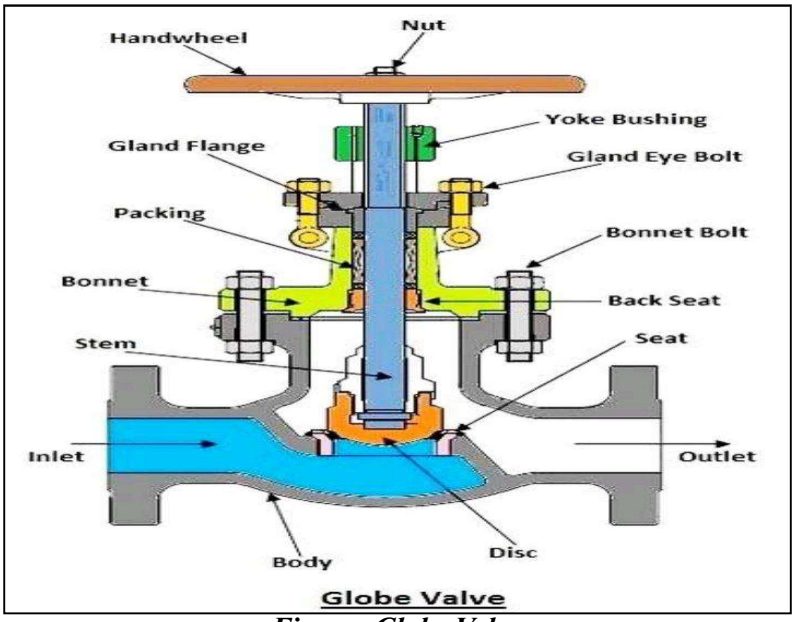

Figure: Globe Valve

6. Needle Valve:

A needle valve is a manually operated valve designed for accurate control of low flow rates by means of a tapered needle-like disc that fits into a matching seat. Needle valves are commonly used in **instrumentation and control systems** where precise adjustment of flow or pressure is required. They are often installed near pressure gauges, transmitters, and analyzers to isolate instruments and control small fluid streams accurately.

- Rotating the handwheel moves the needle up or down.
- Raising the needle increases the flow area and allows fluid to pass.
- Lowering the needle reduces the flow area and can completely stop the flow.
- The fine threads on the stem provide very precise flow adjustment.

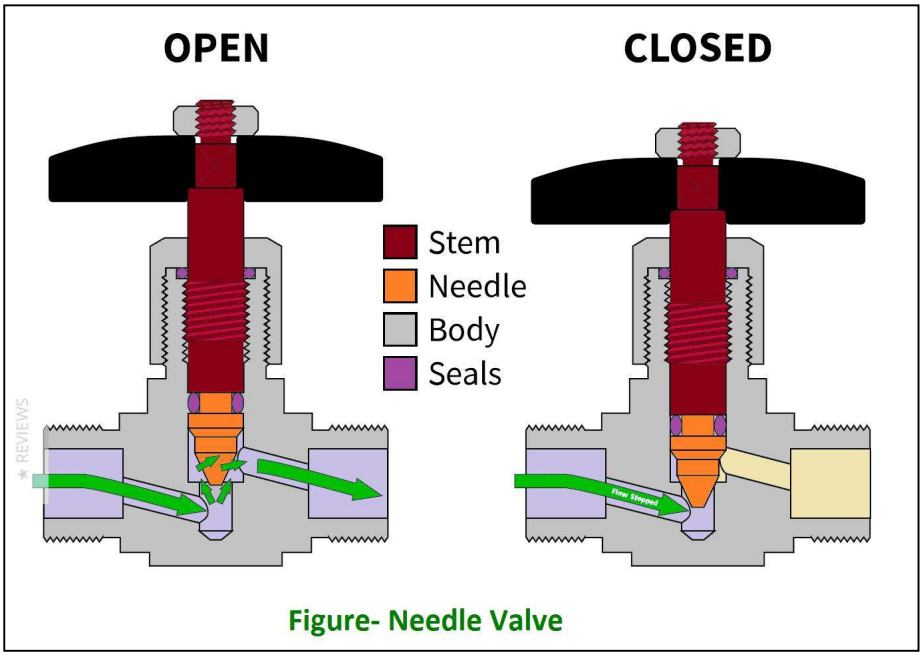

Figure- Needle Valve

7. **Pinch Valve:**

A pinch valve is a valve in which flow is controlled by mechanically squeezing a flexible elastomer sleeve until the fluid passage is partially or completely closed. Pinch valves are particularly useful in services involving **abrasive slurries, drilling fluids, and solids-containing streams** where conventional valves may suffer from erosion or clogging. Since the process fluid only contacts the elastomer sleeve, pinch valves offer good resistance to wear and corrosion.

- In the **open position**, the sleeve remains fully open, allowing unrestricted flow.
- When the actuator is operated, the sleeve is compressed (pinched).
- Further compression reduces flow and can completely stop it.
- The fluid contacts only the sleeve, not the metal body.

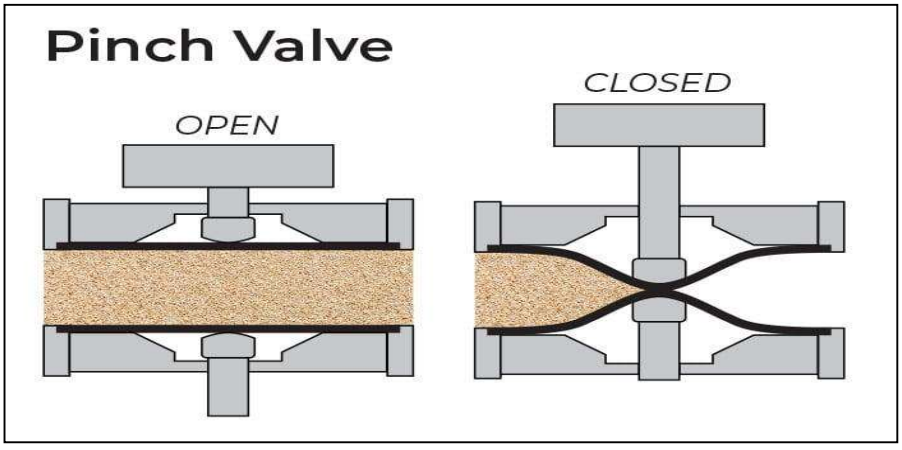

Figure: Pinch Valve

8. Plug Valve:

A plug valve is a rotary valve in which a cylindrical or conical plug is rotated 90° to open, close, or direct fluid flow. Plug valves are widely used for **isolation and switching duties** in oil and gas facilities. They are particularly useful where fast operation, compact design, and reliable shut-off are required. Lubricated plug valves are commonly found in hydrocarbon service because the lubricant helps reduce friction and improve sealing.

- The plug contains a passage (port) through its center.
- When the port aligns with the pipeline, fluid flows through the valve.
- Rotating the plug **90°** positions the solid side against the flow path, stopping the flow.
- Operation can be manual, pneumatic, hydraulic, or electric.

Types of Plug Valves

- Lubricated Plug Valve
- Non-Lubricated Plug Valve
- Eccentric Plug Valve
- Multi-Port Plug Valve

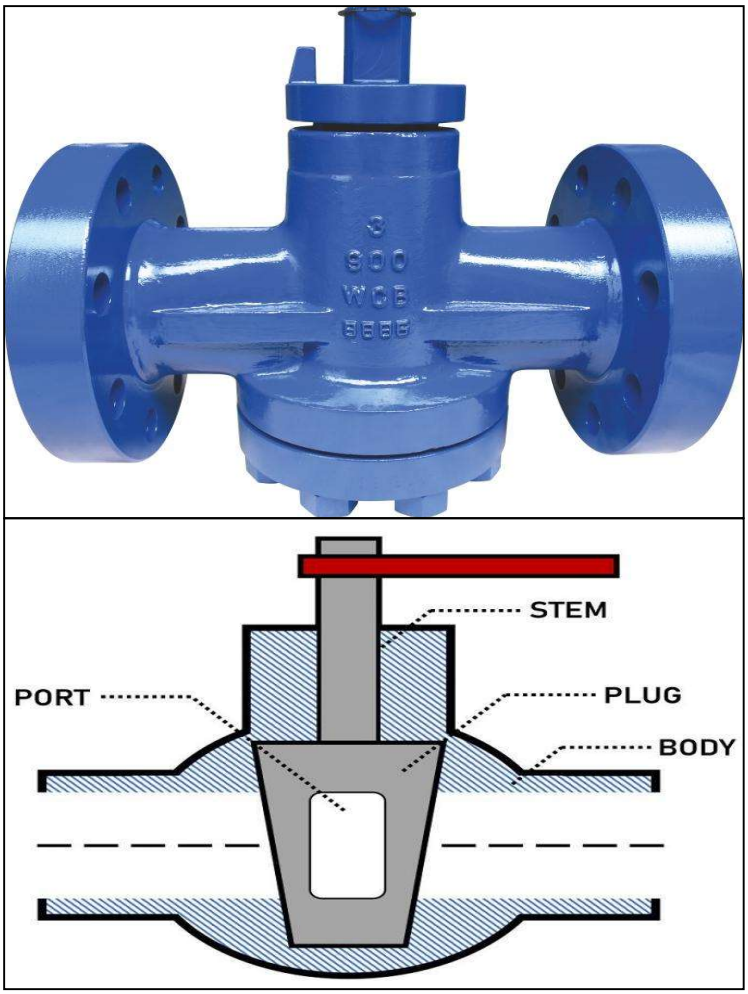

Figure: Plug Valve

9. Pressure Relief Valve (PRV):

A pressure relief valve is an automatic safety valve that opens when system pressure exceeds a preset value and closes when the pressure returns to a safe level. PRVs are among the most critical safety devices in oil and gas facilities. They protect pipelines, vessels, pumps, compressors, and processing equipment from excessive pressure that could lead to equipment failure, leaks, explosions, or environmental incidents.

- Under normal operating conditions, the spring force keeps the valve closed.
- When system pressure exceeds the **set pressure**, the fluid force overcomes the spring force.
- The disc lifts from the seat, allowing excess fluid to escape.
- Once pressure drops below the set value, the spring pushes the disc back onto the seat, closing the valve.

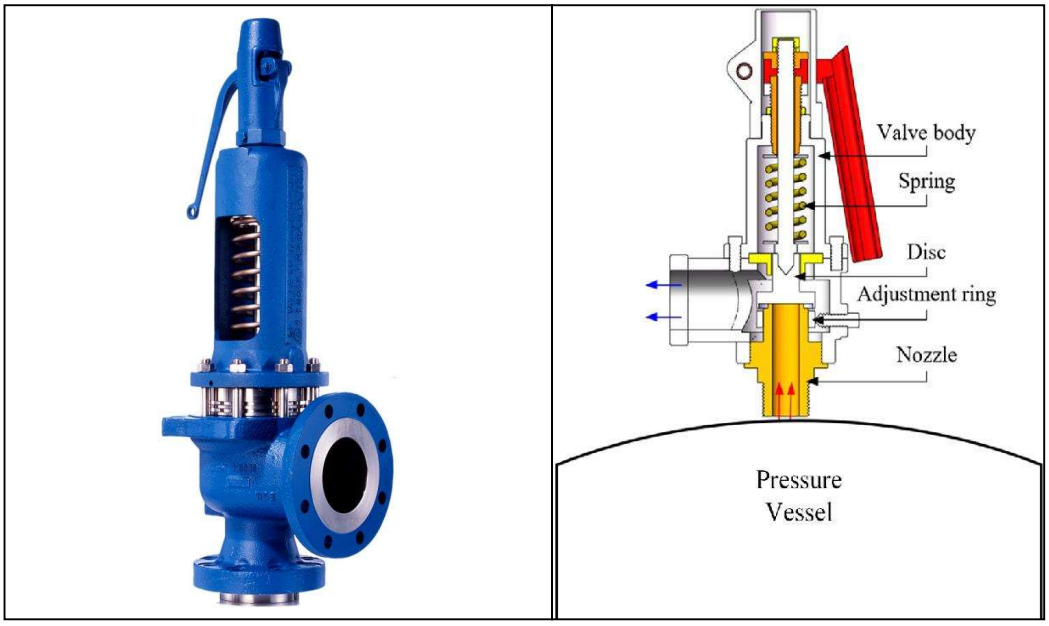

Figure: Pressure Relief Valve (PRV)

Valve Type	Main Function
Gate Valve	Isolation
Ball Valve	Quick shut-off
Globe Valve	Flow regulation
Check Valve	Prevent backflow
Needle Valve	Precision control
Plug Valve	Quick isolation
Pressure Relief Valve	Overpressure protection

Bean:

A bean is the flow-restricting element of a choke system. Its calibrated orifice determines how much fluid can flow through the wellhead or choke manifold, making it a critical component in oil and gas production control. During production, a bean helps maintain controlled flow from the reservoir, preventing excessive production rates that could damage the reservoir or surface equipment. It is especially important in high-pressure wells where accurate flow control is required.

Working Principle

- **Available in different diameters (e.g., 8/64", 16/64", 24/64")**
- Well fluids pass through the bean's orifice.
- The restricted opening reduces pressure and controls flow.
- Different flow rates are achieved by changing the bean size.

Beans are commonly manufactured from:

- Tungsten Carbide
- Hardened Steel
- Ceramic materials (special applications)

Tungsten carbide is preferred because of its excellent erosion resistance.

Applications

- Wellheads
- Christmas trees
- Choke manifolds
- Production testing units
- High-pressure oil and gas wells

Types

- Fixed Bean (Positive Choke Bean) – Fixed orifice size.
- Adjustable Choke Bean – Flow area can be varied through choke adjustment.

Figure: Bean

Bean Housing:

A bean housing is a high-pressure mechanical enclosure designed to accommodate a choke bean and withstand the pressure, temperature, and flow conditions of oil and gas production systems. Bean housings are essential components of **positive choke systems** used to regulate well production. They provide the structural integrity required to safely contain high-pressure oil and gas while allowing operators to change bean sizes to adjust production rates.

Working Principle

- Well fluid enters the housing.
- The housing directs flow through the bean's calibrated opening.
- The restriction causes a pressure drop and controls flow rate.
- Fluid exits the housing at a controlled rate and pressure.

Functions

- Holds the bean firmly in position.
- Directs fluid through the bean orifice.
- Contains high wellhead pressures safely.
- Allows easy replacement of worn beans.
- Protects the choke assembly from leakage.

Materials

Bean housings are typically manufactured from:

- Forged carbon steel
- Alloy steel
- Stainless steel (corrosive service)

These materials provide high strength and resistance to pressure, erosion, and corrosion.

Applications

- Wellheads
- Christmas Trees
- Choke Manifolds
- Production Test Units
- Surface Production Facilities

Figure: Bean Housing

Bean Wrench:

A bean wrench is a purpose-designed wrench used for handling choke beans during maintenance, replacement, and flow-rate adjustment operations in oil and gas production systems. In positive choke systems, production rates are controlled by changing bean sizes. The bean wrench is therefore an essential maintenance tool, allowing operators and technicians to quickly replace beans and adjust well production safely and efficiently.

Working Principle

- The wrench engages the slot or profile of the bean.
- Torque is applied through the handle.
- The bean is loosened or tightened inside the housing.
- The bean can then be removed or replaced.

Functions

- Remove worn choke beans.
- Install new beans.
- Tighten and loosen bean retainers.
- Facilitate safe maintenance of positive choke assemblies.

Applications

- Wellheads
- Christmas Trees
- Choke Manifolds
- Production Test Facilities
- Surface Production Equipment

Figure: Bean Wrench

Bean Nozzle:

A bean nozzle is a calibrated opening, usually made of erosion-resistant material, through which well fluids pass to regulate production rate and reduce pressure. The **bean nozzle** is the actual **flow-controlling restriction** in a positive choke system. Its diameter determines the amount of fluid that can pass through the choke and therefore directly influences well production rate and pressure drop.

Nozzle Size Designation

Bean nozzle sizes are commonly expressed in **1/64-inch increments**, such as:

Bean Size	Orifice Diameter
8/64 in.	0.125 in.
16/64 in.	0.250 in.
24/64 in.	0.375 in.
32/64 in.	0.500 in.

Working Principle

- High-pressure fluid enters the nozzle.
- The fluid is forced through the small calibrated opening.
- The restriction increases fluid velocity and decreases pressure.
- The resulting pressure drop controls the flow rate from the well.

Materials

Because of severe erosion from high-velocity fluids, bean nozzles are commonly manufactured from:

- Tungsten Carbide (most common)
- Ceramic materials
- Hardened alloy steel

Summary of Different Components

Component	Function
Bean	Replaceable choke insert
Bean Nozzle	Calibrated flow-restricting orifice within the bean
Bean Housing	Pressure-containing body holding the bean
Bean Wrench	Tool used to install/remove the bean

Hammer Union or Wing Union:

A hammer union is a **quick-connect high-pressure pipe fitting** that uses a wing nut tightened with a hammer to create a secure, leak-tight connection between oilfield piping components. It is one of the most common connections found on drilling, testing, and production equipment. Hammer unions are widely used because they allow rapid assembly and disassembly of temporary and permanent piping systems in drilling, completion, and production operations. They are especially valuable where equipment must be frequently rigged up and rigged down.

Common Hammer Union Series

Union Number	Typical Service
100	Low-pressure service
200	Medium-pressure service
400	General service
600	Manifold service
1000	High-pressure service
1502	Sour gas and high-pressure service
2202	Very high-pressure service

Working Principle

- Align the male and female subs.
- Engage the mating surfaces.
- Slide the wing nut over the connection.
- Tighten the wing nut using a hammer.
- The seal ring is compressed, creating a pressure-tight joint.

Figure: Hammer Union or Wing Union

Pressure Gauge:

A pressure gauge is a mechanical or electronic device that measures the pressure of a fluid and displays the value in units such as psi, bar, kPa, or MPa. A **pressure gauge** is the primary instrument used to measure and display fluid pressure in oil and gas systems. The most common type is the **Bourdon tube pressure gauge**, which converts pressure into mechanical movement and displays the value on a calibrated dial. Accurate pressure measurement is required for reservoir management, drilling operations, production control, pipeline monitoring, and process safety.

Working Principle

- Fluid pressure enters the gauge through the inlet.
- The pressure acts on the **Bourdon tube**, causing it to straighten slightly.
- This movement is transmitted through gears and linkages.
- The pointer moves across the dial and indicates the pressure value.

Types of Pressure Gauges

- Bourdon Tube Pressure Gauge (most common)
- Diaphragm Pressure Gauge
- Digital Pressure Gauge
- Differential Pressure Gauge
- Vacuum Pressure Gauge
- Compound Pressure Gauge (vacuum + pressure)

Applications in Oil & Gas Industry

- Wellhead pressure monitoring
- Christmas tree installations
- Choke manifolds
- Drilling mud systems
- Pump discharge lines
- Compressors
- Separators and pressure vessels
- Pipelines

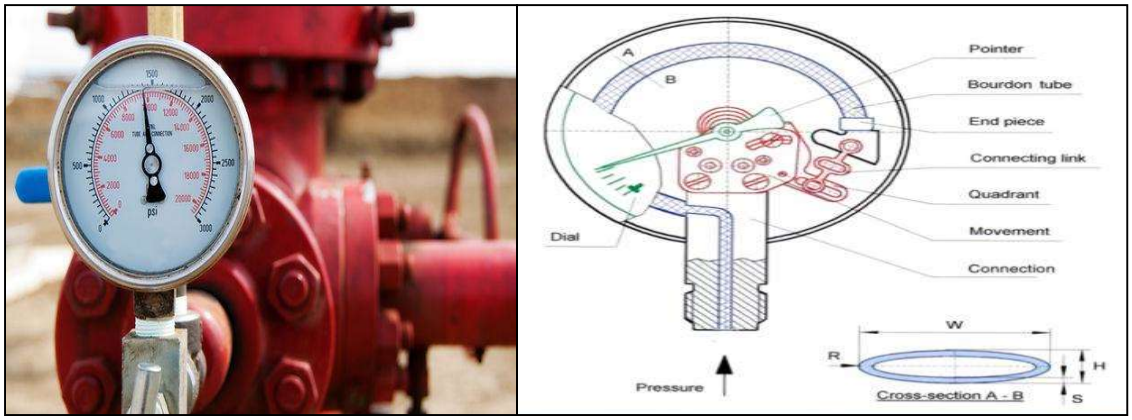

Figure: Pressure Gauge